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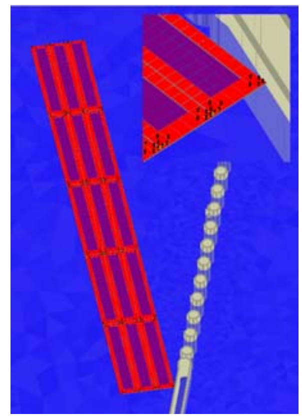
Engineer Research and Development Center

Dynamic Simulation of Barge Train Interaction with Navigation Structures

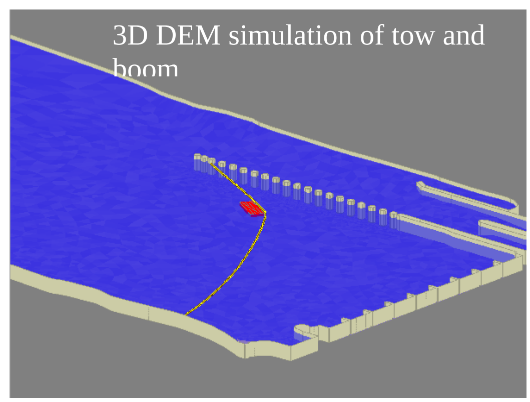
Description

This project addresses the need for realistic computational modeling tools to simulate the interaction of barges and barge-trains with navigation structures including lock approaches, guard walls, piers, lock walls and gates. Barges are composed of discrete panels that can flex and are joined by a realistic arrangement of lashings. The barges interact with a water surface that is computed by the ADH hydraulic model. This package will provide tools to enable Corps Districts to compute forces on structural components at locks and dams and design mitigation measures for runaway barges. This work supports the Corps business practice areas of navigation, inland flood control, emergency management, and support for others.



Issue

There are no realistic computational modeling tools to simulate the interaction of barges and barge-trains with Corps navigation structures. Consequently, physical models are the only design tools currently available. However, physical models are resource intensive and can suffer from scaling issues in the case of fluid/structure interactions. The goal of this project is to develop a dynamic multi-body model of a barge train and test the model by comparing forces from simulations of barge-train/structure interaction with the 1998 experiments at Robert Byrd Lock. Currently the best estimates of forces exerted by barges and trains on lock structures are based on limited experimental data and the modeling of Arroyo and Ebeling. Arroyo and Ebeling constructed a model of a barge-train/lock interaction that is based on two critical assumptions. First, that the peak force exerted by barge-train impact on a structure is limited by lashing failure and, second, that the lashing failure takes place in a sequence that allows the problem to be reduced to a two-, or, at most, a three-body problem. Both assumptions are questionable and throw uncertainty on current best estimates of impact forces. In this project individual barges are flexible structures composed of many small panels that are welded together such that the overall barge has a realistic compliance. Bits and cleats are fastened to the barge decks. Lashings that have the correct modulus and failure strength are applied to the bits and cleats and tightened to the correct tension. Contacts between barges include friction. The barges contain distributed loads that are the same as in the experiments. The barge train model currently uses hydraulic fields computed with the two-dimensional ADH unsteady flow model.


3D DEM simulation of tow and boom

Users Hydraulic engineers responsible for design of hydraulic efficiency, accident avoidance, and environmental stewardship at CoE projects.

Products 3D modeling system capable of evaluating design alternatives at hydraulic structures.

Benefits Rehabilitation designs to extend a project's life or remedial methods to address accidents at hydraulic structures can be evaluated.

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Partners Cold Regions Research Engineering Laboratory; Coastal & Hydraulics Laboratory.